The vegetation of the protected plots at Thabamhlope Research Station

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Plots at Thabamhlope Research Station represent vegetation which has been protected from grazing and fire for periods of up to forty years. The original grassland of the Thabamhlope Plateau has progressed towards a scrub forest, while the kloof has proceeded towards forest containing *Podocarpus latifolius*. The kloof has now become self-protecting from fire.

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Persele by die Thabamhlope Navorsingstasie verteenwoordig plantegroei wat vir periodes van tot veertig jaar teen brand en beweiding beskerm is. Die oorspronklike grasveld van die Thabamhlope-plato het na kreupelhoutwoud verander, terwyl die kloof verander het in 'n woud met hervestiging van *Podocarpus latifolius*. Die kloof het nou selfbeskermend teen vuur geword.

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Introduction

Land for the Thabamhlope Research Station, situated about 30 km south-west of Estcourt, Natal, was acquired in 1936 for investigations into the problems of conserving water, soil and vegetation in Highland Sourveld (Scott 1952). The term Highland Sourveld was first used by Pentz (1938). Acocks (1975) retained the term to describe his Veld Type No 44(a). This is the veld of the eastern slopes and foothills of the Drakensberg between approximately 1 350 m and 2 150 m elevation with a mean annual summer rainfall of between 750 mm and 1 500 mm (Acocks 1975). It is essentially a short sour grassveld dominated by *Themeda triandra, Tristachya leucothrix* and *Alloteropsis semialata*. The veld is uniform in composition and basal cover, with associated herbs being fairly numerous.

Scott (1952) initiated detailed investigations into the problems of veld management at Thabamhlope Research Station (1 400 m) in 1936. This included the effects of fire and grazing on the vegetation. A 'control' plot (30 m × 40 m) was first protected from fire and grazing in March 1939, by firebreaks and fences, for comparison with various other treatments. This plot will be referred to in the remainder of this paper as the *Buddleja salviifolia* plot. West (1951) was able to record the vegetation of this protected plot in March 1939.

According to Fisher (pers. comm.), a second plot (referred to in this paper as the *Leucosidea sericea* plot) was protected by firebreaks and fences at the instigation of West in 1945 because of the presence of *Cliffortia linearifolia*. No floristic analysis was undertaken in this plot during 1945 because the plot was protected to conserve a single species.

Meanwhile, on the Draycott Plain situated adjacent to, but at a slightly lower altitude than Thabamhlope, extreme overgrazing coupled with autumn burning had led to the deterioration of the vegetation and water supply. This was so extensive that when the farm De Hoek was expropriated in 1945, water had to be brought in for the tractors. At this time, Pentz initiated a further protection plot which incorporated a kloof leading up to the Thabamhlope Research Station. This became known as the De Hoek protected kloof. The kloof was not adequately protected by firebreaks until 1956. In 1958, a fire with 40-m flames jumped a 140-m firebreak, but was unable to penetrate the moist, moribund vegetation in the kloof. The kloof is now

self-protecting against fire and has not been affected by fire since (Fisher, pers. comm.). At present, a perennial stream flows through the kloof. No floristic analysis was made of the kloof in 1945 because the main consideration in protecting the vegetation was improvement of the water supply.

During March 1979 an investigation was conducted to determine the vegetation changes that had occurred in the three protected plots during the last forty years.

Study area

The first protected plot that was investigated was the *Leucosidea sericea* plot initiated by West in 1945 to conserve *Cliffortia linearifolia*. This plot is situated on the northern bank of the Little Bushmans River, about 2 km from the Research Station on the Thabamhlope Plateau (Figure 1). At present it is dominated by *Leucosidea sericea* and is surrounded by grassland. The area protected is at present considerably larger than the original protected area. This is because the vegetation inside the plot encroached outside the limits of the fences and the fences were moved to incorporate the encroached area.

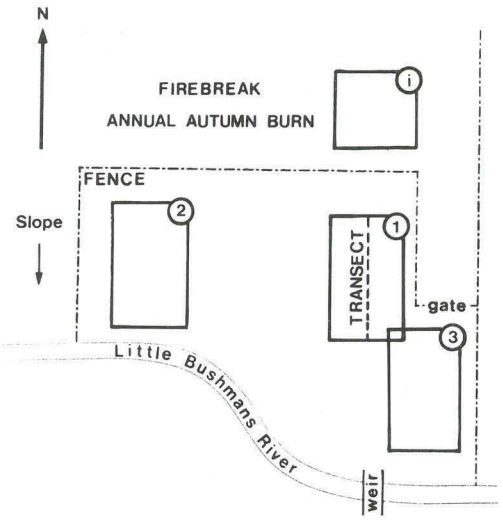


Figure 1 Sample quadrats in the *Leucosidea sericea* protected plot (schematic). (20 × 50 m quadrats numbered 1 – 3, 25 × 25 m quadrat numbered i.)

The second protected plot investigated was that initiated by Scott in 1939. It is situated on the Thabamhlope Plateau in Catchment 14 and is at present dominated by *Buddleja salviifolia* (Figure 2). The third protected plot investigated was that on the De Hoek kloof initiated by Pentz in 1945 (Figure 3). The upper part of the kloof falls within the altitudinal range of Highland Sourveld as described by Acocks (1975) and the lower part within the altitudinal range of Southern Tall Grassland (Acock's Veld Type No. 65). The vegetation in the protected plot is heterogeneous with no apparent physiognomically or floristically dominant plant species.

Methods

A vegetation assessment using a qualitative method, to determine floristic composition and species diversity, and a quantitative method, to determine relative percentage density and basal cover, was carried out.

Qualitative methods

The two protected plots situated on the plateau were sampled by means of 1 000-m^2 quadrats where species were recorded in areas ranging from 1 m^2 to 1 000 m^2 namely, ten areas of 1 m^2 (1 m × 1 m), two of 10 m^2 (2 m × 5 m), one of 100 m^2 (10 m × 10 m) and the full 1 000 m^2 (20 m × 50 m) (Whittaker *et al.* 1979). Floristic composition and alpha diversity (Whittaker *et al.* 1979) were determined. Three permanently marked 1 000-m^2 quadrats were sampled in the *Leucosidea sericea* protected plot (Figure 1) and two permanently marked 1 000-m^2 quadrats in the *Buddleja salviifolia* protected plot (Figure 2). The large area of the quadrats in relation to plot area did not justify random placement of the quadrats (Figures 1 & 2). However, the vicinities of fences were avoided to reduce any edge effects.

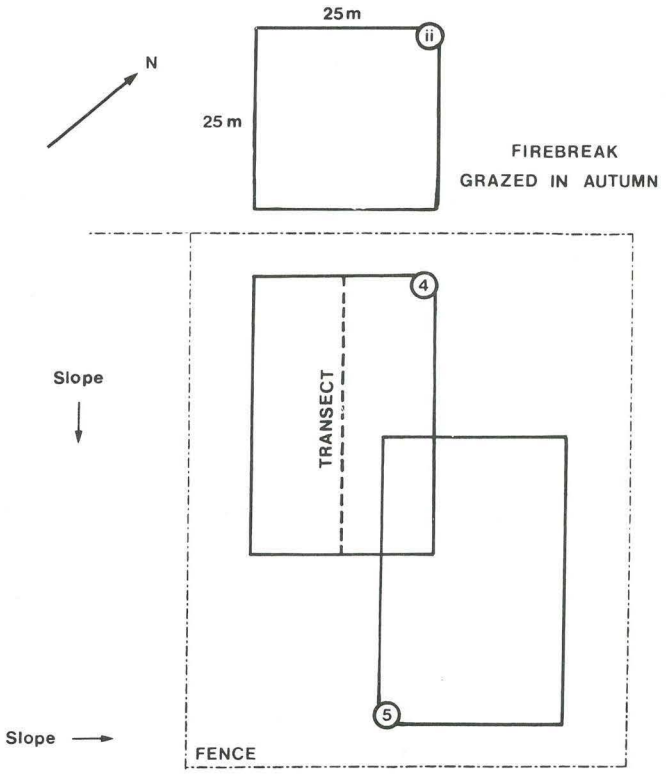


Figure 2 Sample quadrats in the *Buddleja salviifolia* protected plot (schematic), in Catchment 14. (20 × 50 m quadrats numbered 4 and 5, 25 × 25 m quadrat numbered ii.)

The vegetation of the De Hoek protected kloof was sampled along three contours, namely, 1 280 m, 1 340 m and 1 400 m using thirty-three 2 m × 5 m permanently marked quadrats (Figure 3). Quadrat 17 was, however, situated on the 1 370 m contour because the position at which this quadrat would have been sited on the 1 400 m contour was inaccessible (Figure 3). The quadrats were spaced at approximately equal intervals along each contour with the 5-m edge of the quadrats placed along the contours. The steep gradients rendered the use of quadrats larger than 2 m × 5 m impracticable.

The 1 000-m^2 quadrats were permanently marked by

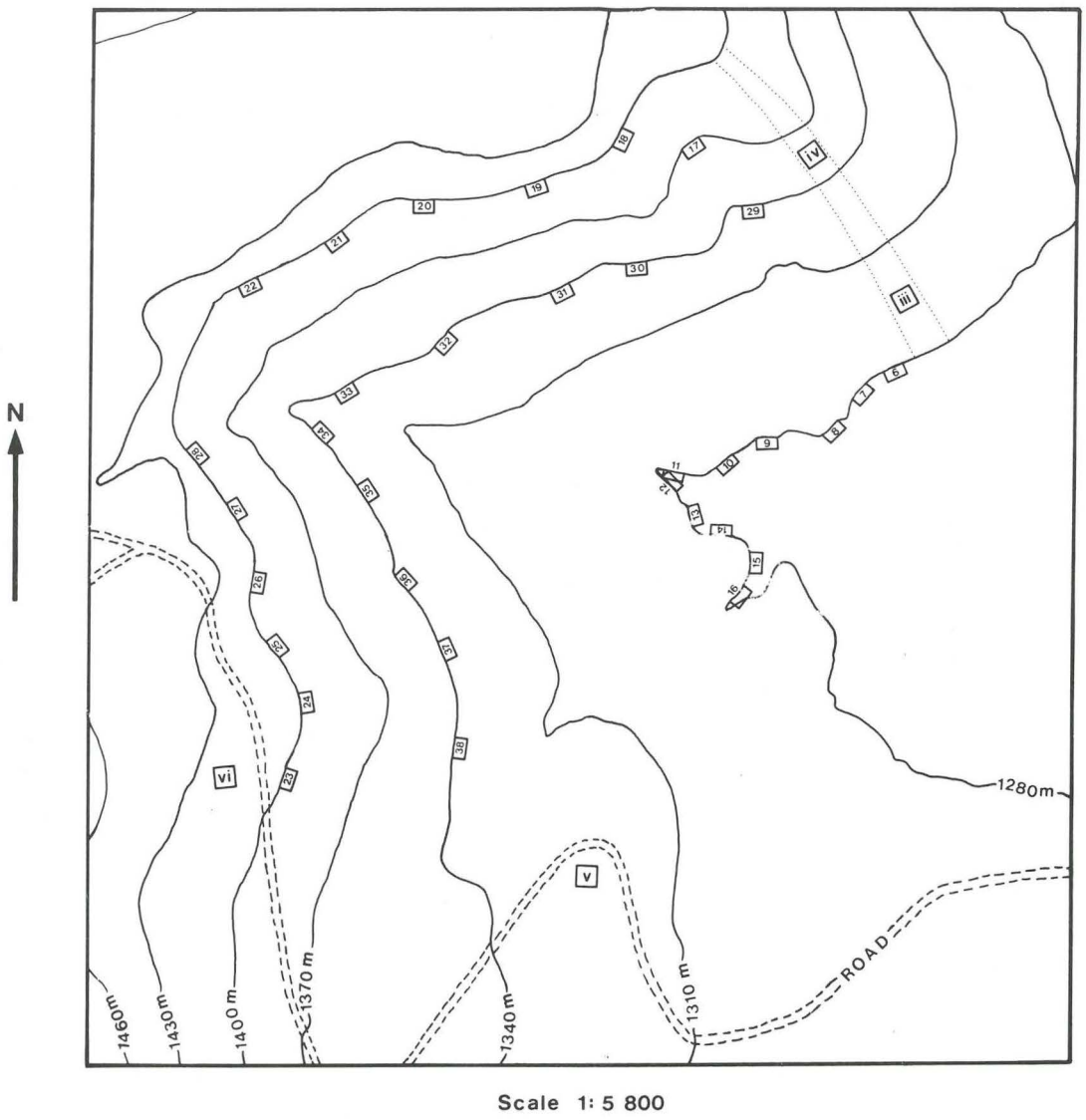


Figure 3 Sample quadrats in the De Hoek protected kloof. (2 × 5 m quadrats numbered 6 – 38; 25 × 25 m quadrats numbered iii – vi).

yellow-topped fencing standards at each corner of the quadrat with a single corner tagged as indicated by the circled numbers in Figures 1 and 2. The 2 m × 5 m quadrats were each permanently marked by two yellow-topped fencing standards placed at the extremes of the 5-m edge of each quadrat. Each quadrat was numbered with a metal tag (Figure 3). The edges of the quadrats thus marked lay along the contour with the two unmarked corners of the quadrats, two metres downslope.

Permanently recognizable species in each quadrat were recorded and specimens were collected for identification and mounting by the National Herbarium in Pretoria. The mounted specimens are currently housed at the Thabamhlope Research Station.

Quantitative methods

A ten-point bridge (with points spaced 15 cm apart) was used to derive estimates of species composition (Tainton, Edwards & Mentis 1980). The nearest plant-to-point method was used for estimating relative percentage density and the number of strikes to estimate basal cover. These estimates were then used to determine the Veld Condition Index according to Tainton, Edwards & Mentis (1980).

The two plateau plots were sampled by means of a 50-m transect running from north to south in Quadrat 1 (Figure 1) and north-west to south-east in Quadrat 4 (Figure 2). Along each transect 300 nearest plant and basal cover estimates were recorded (30 positions of the bridge). The vegetation of the De Hoek kloof was sampled by 6-m transects, of 40 points each (4 bridge positions), along the contours with each transect including each of the 2 m × 5 m quadrats (Figure 3).

The firebreaks adjacent to the protected plots were also sampled by means of six 25 m × 25 m quadrats, with the bridge placed at random to record 200 points in each quadrat (Quadrats i to vi; Figures 1, 2 & 3). Since areas that are periodically burnt are considered to be representative of 'undisturbed veld'[a] (West 1951), the species compositions of the firebreaks were used as base-line data.

In order to assess the condition of the veld in the various quadrats, the species compositions were compared with that of the benchmark site. This is defined as a site that is in

[a]The grassland of the Thabamhlope Plateau is considered to be a fire-maintained sub-climax, and periodic fire is therefore not regarded as a disturbance.

a condition which will allow for maximum forage production and afford good protection to the soil. The benchmark used was that defined by Tainton *et al.* (1980) for Highland Sourveld.

Results

The species recorded in the *Leucosidea* and *Buddleja* protected plots are shown in Tables 1 and 2 respectively. The computations for the veld condition scores of the surrounding firebreaks, together with percentage composition and basal cover, are presented in Table 3. The effect of protection on the plateau plots is summarized in Table 4 where the composition scores of the protected plots were significantly lower than those of the surrounding firebreaks.

The alpha diversities for the plateau protected plots are illustrated graphically (Figure 4) by linear regressions of the species-area curves, on a linear species number, log area scale, for Quadrats 1 to 5.

The species recorded in the De Hoek protected kloof are given in the form of a presence-absence table (Table 5) according to the three sampled contours with species arranged in order of frequency. The matrix values of this table indicate the species composition. The species composition and basal cover estimates of the firebreak quadrats (Quadrats iii to vi; Figure 3) are given in Table 6 and compared to the kloof plots in Table 7.

Discussion

The *Leucosidea sericea* protected plot

Acocks (1975) describes Highland Sourveld in the more level parts, such as the Thabamhlope Plateau, as grassveld that has replaced forest. Although the original vegetation was not recorded for the *Leucosidea sericea* protected plot in 1945, with the exception of the presence of *Cliffortia linearifolia*, the surrounding vegetation suggests that it was essentially grassveld. West (1951) describes the *Leucosidea sericea* Consocies as a principal seral community with an evergreen mountain forest climax. This consocies occurs naturally along stream-banks and forms fringing zones along the lower margins of existing forest patches where sites are moist (West 1951).

The data in Table 1 show that 51,6% of the species recorded in this plot were grasses and 36,9% were herbs and shrubs. Of the 51,6% grasses, *Themeda triandra* represented only 3,0%, while *Eragrostis curvula* (14,3%) and *Arundinella nepalensis* (13,0%) were the most common. In comparison, *Themeda triandra* was the dominant species (38,0%) in the firebreak quadrats (Table 3) while *E. curvula* and *A. nepalensis* were not even recorded in the firebreak area. These changes were reflected in the veld condition scores (Table 4) where decreaser species (i.e. species which occur in veld in good condition and decrease with poor management, including protection) comprised 39% in the firebreak and only 4,7% in the protected plot. Also noticeable was the significant increase in the forest precursor shrub, *Leucosidea sericea*, which was the third most abundant species in the protected plot. Although these data did not show *L. sericea* to be the most abundant species, it was certainly the physiognomically dominant species of the protected plot.

Table 1 Floristic and species composition of the *Leucosidea sericea* protected plot. Species composition, where recorded with the bridge-point apparatus, is indicated in brackets

Acalypha schinzii Pax
Acalypha wilmsii Pax ex Prain & Hutch. (0,3%)
Agapanthus sp.
Agrostis eriantha Hack.
Agrostis montevidensis Spreng. ex Nees
Alloteropsis semialata (R. Br.) Hitchc. (3,3%)
Anthospermum herbaceum L.f.
Aristida junciformis Trin. & Rupr. (3,7%)
Arundinella nepalensis Trin. (13,0%)
Asparagus setaceus (Kunth) Jessop
Aster bakeranus Burtt Davy ex C.A. Sm.

Berkheya setifera DC.
Bidens pilosa L.
Brunsvigia grandiflora Lindl.
Bulbostylis humilis (Kunth) C.B.Cl. (2,0%)

Chenopodium album L.
Cliffortia linearifolia Eckl. & Zeyh.
Clutia monticola S. Moore
Commelina africana L. (1,0%)
Conyza floribunda H.B.K. (9,3%)
Conyza pinnata (L.f.) Kuntze (0,3%)
Crassula setulosa Harv.
Cyperus sp.

Desmodium natalitium Sond.
Dicoma anomala Sond. subsp. *circioides* (Harv.) Wild
Digitaria diagonalis (Nees) Stapf
Digitaria ternata (A. Rich.) Stapf (3,0%)
Digitaria tricholaenoides Stapf
Diheteropogon amplectens (Nees) W.D. Clayton
Diheteropogon filifolius (Nees) W.D. Clayton
Dryopteris inaequalis (Schlechtd.) Kuntze

Elionurus muticus (Spreng.) Kunth. (0,7%)
Eragrostis capensis (Thunb.) Trin. non Jedw.
Eragrostis curvula (Schrad.) Nees (14,3%)
Eragrostis plana Nees (0,3%)
Eragrostis racemosa (Thunb.) Steud. (0,3%)
Eriosema salignum E. Mey
Eulophia sp.
Euphorbia striata Thunb. (0,7%)
Euryops transvaalensis Klatt subsp. *setilobus* (N.E.Br) B. Nordenstam

Harpochloa falx (L.f.) Kuntze (1,3%)
Helichrysum adenocarpum DC.
Helichrysum cooperi Harv.
Helichrysum natalitium DC. (3,3%)
Helichrysum nudifolium (L.) Less. var. *nudifolium*
Helichrysum pilosellum (L.f.) Less. (0,3%)
Helichrysum sp. 1
Helichrysum sp. 2
Helichrysum umbraculigerum Less. (2,0%)
Helictotrichon turgidulum (Stapf) Schweick. (1,3%)
Hesperantha sp.
Heteropogon contortus (L.) Beauv. ex Roem. & Schult.
Hibiscus sp.
Hibiscus trionum L. (0,3%)
Hypochoeris radicata L.
Hypoxis argentea Harv. ex Bak.

Table 1 (continued)

Indigofera hedyantha Eckl. & Zeyh.
Indigofera hilaris Eckl. & Zeyh.
Iridaceae juvenile (0,7%)

Kniphofia sp.

Lasiosiphon caffer Meisn.
Ledebouria floribunda (Bak.) Jessop
Leucosidea sericea Eckl. & Zeyh. (9,7%)
Lightfootia sp.
Littonia modesta Hook.

Mariscus congestus (Vahl) C.B.Cl.
Microchloa caffra Nees
Mohria caffrorum (L.) Desv.
Monocymbium ceresiiforme (Nees) Stapf
Monsonia attenuata Harv.

Nidorella auriculata DC.

Ophioglossum sp. cf. *O. vulgatum* L.
Oxalis corniculata L.
Oxalis obliquifolia Steud. ex Rich. (4,7%)

Panicum aequinerve Nees
Panicum natalense Hochst. (0,7%)
Paspalum dilatatum Poir.
Pellaea viridis (Forsk.) Prantl (1,7%)
Psoralea sp.

Rubus rigidus Sm.
Rumex angiocarpus Murb. (2,0%)
Rumex sagittatus Thunb.

Scleria sp., cf. *S. dregeana* Kunth
Senecio bupleuroides DC.
Senecio inaequidens DC. (1,3%)
Senecio isatideus DC. (0,3%)
Senecio sp.
Setaria sphacelata (Schumach.) Stapf & C.E. Hubb. ex M.B. Moss
Setaria ustilata de Wit (1,3%)
Solanum retroflexum Dun.
Sonchus wilmsii R.E. Fr.
Sutera floribunda (Benth.) Kuntze

Themeda triandra Forsk. (3,0%)
Trachypogon spicatus (L.f.) Kuntze (0,7%)
Tristachya leucothrix Nees (4,7%)

Vernonia hirsuta (DC.) Sch. Bip. var. *hirsuta*
Vernonia sp.

Wahlenbergia undulata A. DC.

Zantedeschia sp.

Relative percentage density recorded with bridge-point apparatus	
Grasses	51,6%
Sedges	2,0%
Ferns	1,7%
Geophytes	0,7%
Other dicotyledons	36,2%
Bare ground[a]	7,8%
	100,0%

[a]A point was considered to represent bare ground when no plants were recorded within a 75-mm radius of the point.

Table 2 Floristic and species composition of the *Buddleja salviifolia* protected plot. Species composition, where recorded with the bridge-point apparatus, is indicated in brackets

Acalypha wilmsii Pax ex Prain & Hutch (2,0%)
Achyranthes aspera L.
Agrostis lachnantha Nees.
Alloteropsis semialata (R.Br.) Hitchc. (0,3%)
Aristida junciformis Trin. & Rupr. (6,7%)
Asparagus setaceus (Kunth) Jessop

Boophane sp.
Buddleja salviifolia (L.) Lam. (5,7%)

Chenopodium album L. (0,3%)
Commelina africana L. (0,7%)
Conostomium natalense (Hocst.) Brem. var. *glabrum* Brem.
Conyza floribunda H.B.K. (4,3%)
Conyza pinnata (L.f.) Kuntze (1,7%)
Cyathula uncinulata (Schrad.) Schinz
Cynoglossum lanceolatum Forsk.
Cyperus sp.

Diospyros lycioides Desf. subsp. *lycioides*

Eragrostis curvula (Schrad.) Nees

Helichrysum nudifolium (L.) Less. var. *nudifolium*
Helichrysum sp. 1
Hyparrhenia hirta (L.) Stapf (13,3%)

Knowltonia sp. cf. *K. transvaalensis* Szyszyl.

Mohria caffrorum (L.) Desv. (8,7%)

Nidorella auriculata DC.

Oxalis corniculata L.
Oxalis obliquifolia Steud. ex Rich. (14,7%)

Pellaea viridis (Forsk.) Prantl (11,3%)

Rabdosia calycina (Benth.) Codd
Rhus dentata Thunb. (1,0%)
Rubus ludwigii Eckl. & Zeyh. (1,7%)
Rubus sp. (4,3%)
Rumex angiocarpus Murb. (0,3%)
Rumex sagittatus Thunb. (0,3%)

Setaria sphacelata (Schumach.) Stapf et C.E. Hubb.
Setaria ustilata de Wit (11,7%)
Solanaceae sp.
Sporobolus africanus (Poir.) Robyns & Tournay (1,0%)

Tagetes minuta L.

Vernonia neocorymbosa Hilliard (2,0%)
Vernonia sp.

Zantedeschia sp. (1,0%)

Relative percentage density recorded with bridge-point apparatus	
Grasses	33,0%
Sedges	2,7%
Ferns	20,0%
Other monocotyledons	1,0%
Other dicotyledons	39,3%
Bare ground[a]	4,0%
	100,0%

Total basal cover recorded with bridge-point apparatus 0,7%

[a]A point was considered to represent bare ground when no plants were recorded within a 75 mm radius of the point.

Table 3 Species composition and veld condition scores of the firebreaks surrounding the *Leucosidea sericea* and *Buddleja salviifolia* protected plots. Species composition was determined by the nearest-plant method, using a bridge-point apparatus

		Benchmark site		Firebreak surrounding *Leucosidea* plot[a]		Firebreak surrounding *Buddleja* plot[b]	
Species class	Species	Relative % density	Max. limit	Relative % density	Score	Relative % density	Score
Decreaser	*Trachypogon spicatus*	2	12	1,0	1,0	1,0	1,0
	Themeda triandra	45	55	38,0	38,0	17,0	17,0
	Heteropogon contortus	4	14	–	–	2,0	2,0
	Monocymbium ceresiiforme	2	12	–	–	3,0	3,0
	Diheteropogon amplectans	1	11	–	–	0,5	0,5
	Eragrostis capensis	1	11	–	–	10,5	10,5
	Brachiaria serrata	1	11	–	–	–	–
	Eragrostis racemosa	1	11	–	–	–	–
		57		39,0	39,0	34,0	34,0
Increaser I	*Harpochloa falx*	3		4,5	3,0	11,5	3,0
	Unidentified grass species	–		3,0	0,0	–	–
	Andropogon sp.	–		2,5	0,0	–	–
	Digitaria trichlaenoides	–		–	–	1,0	0,0
	Tristachya leucothrix	20		26,5	20,0	16,0	16,0
	Alloteropsis semialata	2		7,5	2,0	1,5	1,5
	Eulalia villosa	1		–	–	–	–
		26		44,0	25,0	30,0	20,5
Increaser II	*Microchloa caffra*	1		0,5	0,5	–	–
	Eragrostis plana	1		–	–	4,5	1,0
	Eragrostis curvula	1		–	–	1,5	1,0
	Sporobolus africanus	–		–	–	15,5	0,0
	Hyparrhenia hirta	1		–	–	- 2,5	0,0
	Sedges	–		–	–	4,5	0,0
	Herbs	6		14,0	6,0	3,0	3,0
		10		14,5	6,5	31,5	6,0
Increaser III	*Elionurus muticus*	5		1,5	1,5	4,0	4,0
	Koeleria cristata	–		1,0	0,0	–	–
	Rendlia altera	–		–	–	0,5	0,0
	Diheteropogon filifolius	2		–	–	–	–
		7		2,5	1,5	4,5	4,0
Total		100		100,0	72,0	100,0	64,5

[a]Basal cover = 5,0% [b]Basal cover = 8,5%

Table 4 Veld condition presentation of the *Leucosidea sericea* and *Buddleja salviifolia* protected plots, derived similarly to Table 3 but not presented, and adjacent firebreaks

	Leucosidea sericea dominated protected plot	Adjacent firebreak	*Buddleja salviifolia* dominated protected plot	Adjacent firebreak
Veld condition score	14,0	72,0	6,3	64,5
Basal cover	1,3	5,0	0,7	8,5
Decreasers	4,7	39,0	0,0	34,0
Increaser I	71,3	44,0	76,3	30,0
Increaser II	19,6	14,5	17,0	31,5
Increaser III	4,4	2,5	6,7	4,5

The *Buddleja salviifolia* protected plot

A botanical analysis of the *Buddleja salviifolia* protected plot by West in 1939 shows that the plot was originally grassland (West 1951). In the present survey (Table 2) *Buddleja salviifolia* is the physiognomically dominant species, but with considerable encroachment by *Rubus* sp. Of the grass species recorded in the present survey, only one grass species, *Alloteropsis semialata*, was recorded by West in 1939. In the adjacent firebreak, however, seven out of the original ten species recorded by West (1951) are still present. This area is, however, not truly representative of 'undisturbed veld' since it is grazed in addition to being burnt annually. The most noticeable feature of the comparison of these two areas is the large amount of *Sporobolus africanus* (15,5% in 1979) in the firebreak (Table 3) which was not recorded in 1939.

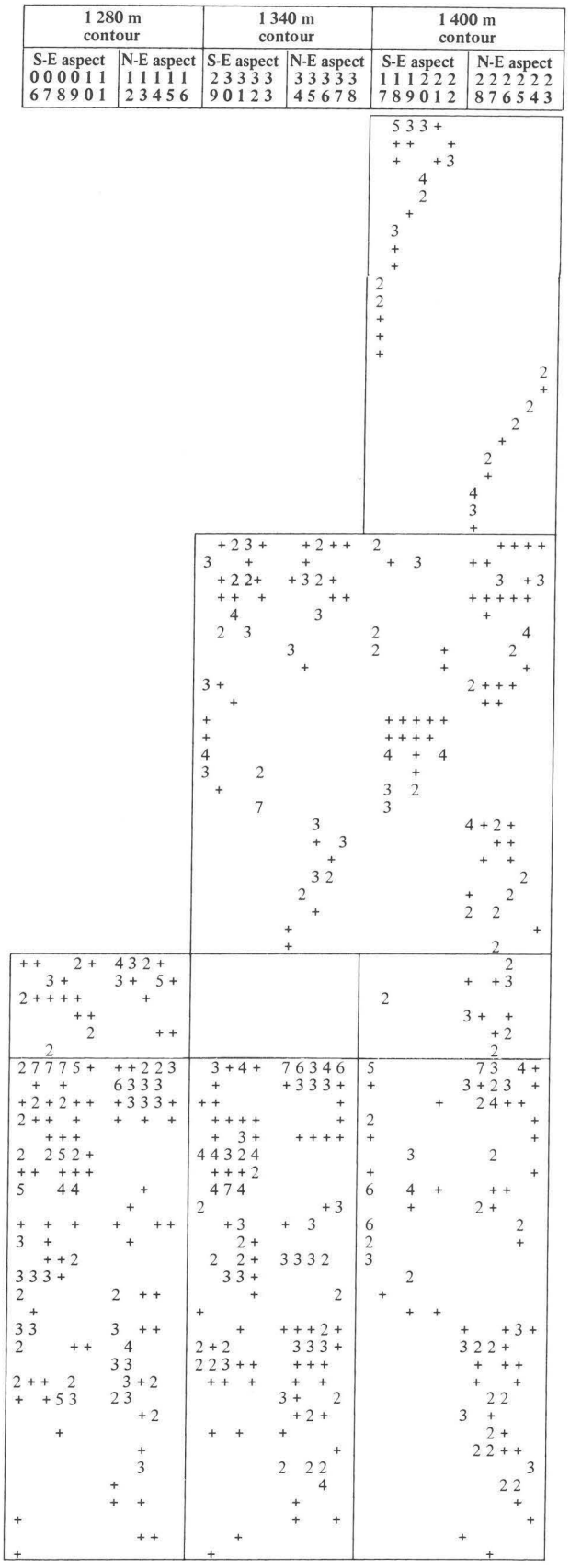
This is probably a direct result of the grazing which has taken place. In spite of this, the veld condition score for the firebreak was 64,5% (Table 4), indicating that the veld is still in good condition relative to that of the *Buddleja salviifolia* protected plot (6,3%).

The difference between the linear regressions for Quadrats 1 to 3 (Figure 4) illustrates the alpha diversity (Whittaker *et al.* 1979) or intra-community diversity for the *Leucosidea sericea* protected plot. The linear regression for Quadrat 3 indicates a lower alpha diversity than that for Quadrats 1

Table 5 Presence – absence table, along altitudinal and aspect gradients of species recorded in the De Hoek protected kloof with matrix values* indicating plant percentage density, of species per quadrat, recorded with a bridge-point apparatus

	1 280 m contour		1 340 m contour		1 400 m contour	
	S-E aspect	N-E aspect	S-E aspect	N-E aspect	S-E aspect	N-E aspect
	000011	111111	233333	333333	111222	222222
	678901	234566	901233	456678	789012	876543
Berkheya rhapontica (DC.) Hutch. & Burtt Davy	+223	44	+2			
Liliaceae sp.	+++	++	+			
Oxalis obliquifolia Steud. ex Rich.	+3	22	3+			
Cyperus sp.	+		623			
Athanasia punctata (DC.) Harv.	2+	+	+			
Linum cf. *L. thunbergii* Eckl. & Zeyh.	22+		2			
Koeleria cristata (L.) Pers.	2	+	23			
Harpochloa falx (L.f.) Kuntze	2	2	4			
Helichrysum adenocarpum DC.	+		+			
Acacia decurrens (Wendl.) Willd.	2+					
Helichrysum natalitium DC.	+	+				
Dais cotinifolia L.		+				
Digitaria ternata (A. Rich.) Stapf		+				
Schistostephium hippiifolium (DC.) Hutch.		+				
Iridaceae juvenile	2					
Digitaria diagonalis (Nees) Stapf	+					
Rhus lucida L.	+					
Alloteropsis semialata (R.Br.) Hitchc.		+				
Hypoestes verticillaris (L.f.) R.Br. ex C.B.Cl.	3					
Rhynchosia cf. *R. minima* (L.) DC.	2					
Indigofera swaziensis H. Bol.	+					
Elionurus muticus (Spreng.) Kunth.		346				
Heteropogon contortus (L.) Beauv. ex Roem.& Schult.		+2				
Paspalum dilatatum Poir.		+ 5				
Senecio inaequidens DC.		++				
Cymbopogon sp.		++				
Digitaria tricholaenoides Stapf		7				
Diheteropogon amplectens (Nees) Clayton		3				
Trachypogon spicatus (L.f.) Kuntze		2				
Cliffortia linearifolia Eckl. & Zeyh.		+				
Euphorbia sp.		+				
Senecio cathcartensis O. Hoffm.		+				
Verbena bonariensis L.		+				
Wahlenbergia undulata A.DC.		+				
Eriosema salignum E. Mey.		+				
Eucomis bicolor Bak.		+				
Psoralea polysticta Benth.		2				
Clausena anisata (Willd.) Hook. f. ex Benth.			22	+		
Ficus tremula Warb.			++			
Diospyros sp.				2		
Rubus ludwigii Eckl. & Zeyh.				+		
Arundinella nepalensis Trin.				+		
Sparmannia ricinocarpa (Eckl. & Zeyh.) Kuntze				+		
Silene burchellii Otth			3			
Unidentifiable sp. 2			2			
Maytenus mossambicensis (Klotzsch) Blakelock			+			
Hermannia sp.					22	
Canthium mundianum Cham. & Schlechtd.					++	
Polygala virgata Thunb.					3	
Cussonia paniculata Eckl. & Zeyh.					+	
Cussonia spicata Thunb.					+	
Teramnus labialis (L.f.) Spreng.					2	
Pellaea calomelanos (Swartz) Link					2	
Senecio sp.					2	
Dicoma anomala Sond.					+	
Grewia hispida Harv.					+	
Rhynchosia cf. *R. reptabunda* N.E.Br.					+	
Leucosidea sericea Eckl. & Zeyh.	+2+23+	+++++		+	2	
Nidorella auriculata DC.	+++++	+		+++		+
Acalypha punctata Meisn.		++			3+	
Diospyros austro-africana De Winter						2
Zantedeschia sp.	+	+				+
Maytenus heterophylla (Eckl. & Zeyh.) N. Robson				3		
Eragrostis capensis (Thunb.) Trin. non Jedw.						
Rhus tomentosa L.	+					

Table 5 (continued)



* Matrix values:

\+ present, but not recorded with bridge-point apparatus
1 less than 1%
2 1–5%
3 6–10%
4 11–15%
5 16–20%
6 21–25%
7 26–50%

Table 6 Species composition and veld condition scores of the firebreaks surrounding the De Hoek protected kloof. Species composition was determined with a bridge-point apparatus

		Benchmark site		Quadrat iii[a]		Quadrat iv[b]		Quadrat v[c]		Quadrat vi[d]	
Species class	Species	Comp. %	Max limit	Comp. %	Score	Comp. %	Score	Comp. %	Score	Comp. %	Score
Decreaser	*Diheteropogon amplectens*	1	11	0,5	0,5	2,0	2,0	8,0	8,0	2,5	2,5
	Eragrostis capensis	1	11	2,5	1,0	7,0	7,0	0,5	0,5	4,5	4,5
	Eragrostis racemosa	1	11	1,5	1,0	–	–	2,0	2,0	–	–
	Heteropogon contortus	4	14	–	–	–	–	0,5	0,5	–	–
	Monocymbium ceresiiforme	2	12	2,5	2,5	–	–	0,5	0,5	1,0	1,0
	Themeda triandra	45	55	20,5	20,5	23,0	23,0	11,0	11,0	10,0	10,0
	Trachypogon spicatus	2	12	4,5	4,5	5,5	5,5	6,5	6,5	2,0	2,0
	Brachiaria serrata	1	11	–	–	–	–	–	–	2,0	2,0
	Paspalum dilatatum	0	–	–	–	1,5	0,0	–	–	–	–
		57		32,0	30,0	39,0	37,5	29,0	29,0	22,0	22,0
Increaser I	*Alloteropsis semialata*	2		0,5	0,5	1,0	1,0	5,5	2,0	7,0	2,0
	Andropogon appendiculatus	0		–	–	–	–	–	–	0,5	0,0
	Tristachya leucothrix	20		17,0	17,0	20,0	20,0	33,0	20,0	35,5	20,0
	Digitaria tricholaenoides	0		–	–	–	–	1,0	0,0	–	–
	Harpochloa falx	3		3,0	3,0	14,5	3,0	2,0	2,0	6,0	3,0
	Imperata cylindrica	0		–	–	–	–	–	–	1,0	0,0
	Cymbopogon validus	0		–	–	1,0	0,0	1,0	0,0	–	–
	Eulalia villosa	1		–	–	–	–	–	–	–	–
		26		20,5	20,5	36,5	24,0	42,5	24,0	50,0	25,0
Increaser II	*Microchloa caffra*	1		–	–	–	–	–	–	–	–
	Eragrostis plana	1		–	–	–	–	–	–	–	–
	Eragrostis curvula	1		–	–	–	–	–	–	–	–
	Hyparrhenia hirta	1		–	–	1,0	1,0	0,5	0,5	1,5	1,0
	Digitaria ternata	0		1,5	0,0	5,0	–	–	–	–	–
	Herbs	6		13,0	6,0	10,5	6,0	7,0	6,0	20,5	6,0
	Sedges	0		32,5	0,0	5,5	0,0	20,0	0,0	–	–
		10		47,0	6,0	22,0	7,0	27,5	6,5	22,0	7,0
Increaser III	*Elionurus muticus*	5		–	–	0,5	0,5	1,0	1,0	4,5	4,5
	Koeleria cristata	0		0,5	0,0	2,0	0,0	–	–	1,5	0,0
	Diheteropogon filifolius	2		–	–	–	–	–	–	–	–
		7									
Total		100		100,0	56,5	100,0	69,0	100,0	60,5	100,0	58,5

[a]Basal cover = 8,0%; [b]Basal cover = 9,0%; [c]Basal cover = 9,0%; [d]Basal cover = 6,0%

Table 7 Veld condition presentation of the De Hoek protected kloof and adjacent firebreaks

	1 280 m contour south-easterly aspect	Firebreak quadrat iii	1 280 m contour north-easterly aspect	1 340 m contour south-easterly aspect	Firebreak quadrat iv	1 340 m contour north-easterly aspect	Firebreak quadrat v	1 400 m contour south-easterly aspect	1 400 m contour north-easterly aspect	Firebreak quadrat vi
Veld condition score	17,0	56,5	8,5	6,0	69,0	6,0	60,5	6,0	8,5	58,5
Cover	2,0	8,0	2,0	1,5	9,0	2,0	9,0	0,0	2,0	6,0
Decreasers	2,0	32,0	0,0	0,0	39,0	0,0	29,0	0,0	0,0	20,0
Increaser I	62,0	20,5	82,0	86,5	36,5	75,5	42,5	46,0	76,0	52,0
Increaser II	23,0	47,0	1,5	3,5	22,0	3,5	27,5	0,0	5,0	22,0
Increaser III	13,0	0,5	0,5	0,0	2,5	1,5	1,0	0,0	0,0	6,0
Bare ground[a]	0,0	0,0	16,0	10,0	0,0	19,5	0,0	54,0	19,0	0,0

[a]A point was considered to represent bare ground when no plants were recorded within a 75-mm radius of the point.

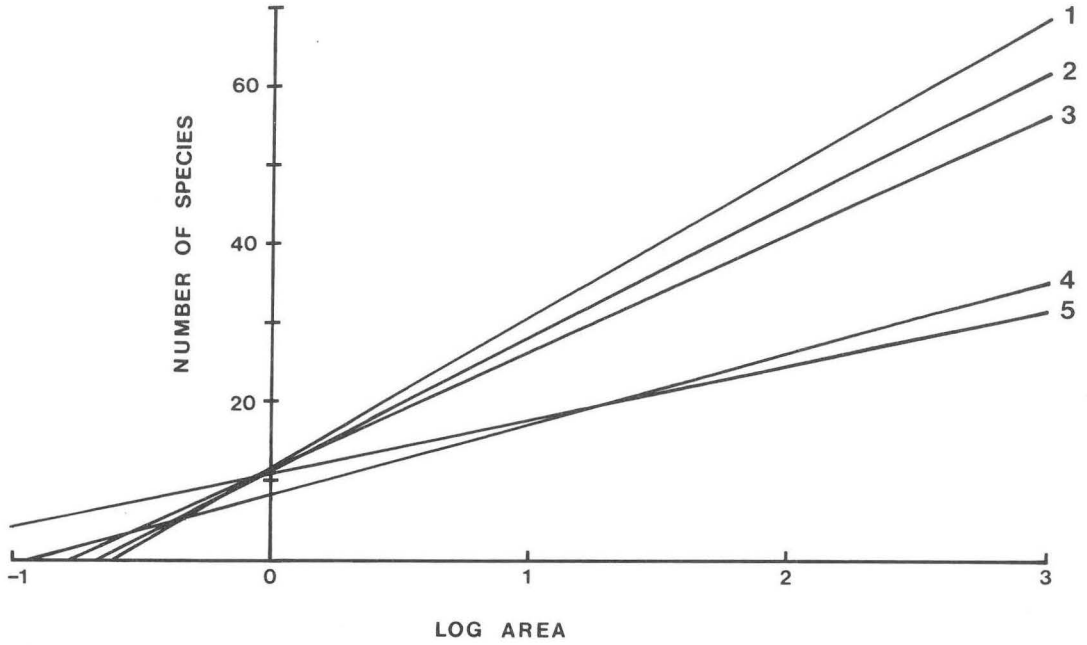


Figure 4 Linear regressions of the species-area curves for Quadrats 1 to 5, illustrating the alpha diversities for the *Leucosidea sericea* protected plot (Quadrats 1 to 3) and the *Buddleja salviifolia* protected plot (Quadrats 4 & 5). Area is recorded in m^2.

and 2 (Figure 4). Quadrat 3 is in a mainly grassland area because the boundary fence was recently moved. The *Leucosidea sericea* stage of vegetation progression would, therefore, have a higher alpha diversity than the grassland it replaced. The *Buddleja salviifolia* protected plot has a considerably lower alpha diversity (Quadrats 4 & 5; Figure 4) than that of the *Leucosidea sericea* protected plot. This may be related to the more xeric conditions in the former.

West (1951) describes the *Buddleja salviifolia* Consocies as occurring naturally on the upper margins of existing forest patches on the more xeric sites. The change in vegetation since the commencement of protection of the plateau plots supports Acocks's (1975) view that the grassland of the Thabamhlope Plateau is a fire-maintained sub-climax, and with protection, succession towards scrub forest takes place.

The De Hoek protected kloof

No floristic analysis was made of the De Hoek kloof in 1945 because the vegetation was protected primarily to improve the stream flow to the Bloukrans River. Acocks (1975) lists numerous species found in forest relics in Highland Sourveld, with *Podocarpus latifolius* clearly dominant. Many of these species were recorded in the De Hoek protected kloof during March 1979 (Table 5). However, *Podocarpus latifolius* is only represented by young trees in the upper contour and is not physiognomically dominant at present. *Leucosidea sericea* is present in all the quadrats of the lower contour (Table 5) and in only two in the middle contour, confirming West's (1951) description of the Consocies. *Buddleja salviifolia* was recorded in three quadrats of the upper contour and in two in the lowest contour.

The intermediate (1 240 m) and upper (1 400 m) contours were characterized by a low percentage of grass species (between 4% and 29%) when compared with the lowest contour, which had 38,5% and 56,0% grasses on the north-easterly and south-easterly aspects respectively. This was reflected in the veld condition scores (Table 7), which were 17,0% and 8,5% on the lowest contour, and 6,0% on all the higher contours. Decreased insolation, brought about by the steeper slopes on the higher contours (Schulze & McGee 1978) may explain these differences. This may create more mesic conditions on the steeper slopes, favouring the encroachment of woody species. The score of 6,0% recorded on the higher contours, was solely owing to the presence of herbs and shrubs, as these contours had no grass species in common with the benchmark site. The most common grass in the De Hoek kloof was *Cymbopogon validus*, which occurred along all three contours.

The veld condition scores for the firebreak plots surrounding the De Hoek kloof (Table 7) ranged from 56,5 to 69% as compared with the 6,0% recorded in the majority of the De Hoek kloof protected plots. Basal cover was also high (6 – 9%) (Table 7) when compared with the protected areas (0 – 2%).

It will be noted (Table 5) that the alien pest plant *Acacia decurrens* was recorded in two of the quadrats of the 1 280-m contour. This plant has proved to be an extremely successful invader below this contour, and may be expected to encroach upwards into the study area with time.

Conclusion

The results indicate that the grassland of the Thabamhlope Plateau is a fire-maintained biotic climax. Protection has led to the grassland being replaced by shrub and forest species. Protection of the De Hoek kloof has contributed to a more stable water supply than prior to protection and to *Podocarpus latifolius* becoming established. Since these plots represent vegetation changes over periods of up to forty years it is urged that protection of the three plots be continued for further successional studies. The data gathered, although not complete, are essentially irreplaceable and pro-

vide the basis for extremely valuable continuity in monitoring vegetation change in this Highland Sourveld (Acocks 1975) environment. Finally, steps should be taken to remove *Acacia decurrens* from the De Hoek kloof and control it to prevent its future encroachment.

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